Module 5

Non-conventional Energy & their Resources

Energy sources

The energy existing in the earth is called capital energy and that comes from outer space is called celestial or income energy.

Capital energy sources are mainly fossil fuels nuclear fuels & heat traps.

Celestial energy sources include electromagnetic, gravitational and particle energy from stars, planets and moon as well as potn energy of meteorites entering Earth's atmosphere.

Renewable & Non-Renewable Energy Resources

The renewable energy resources are defined as the energy sources which are produced continuously in nature & and are essentially inexhaustible, atleast in the time framework of societies eg. direct solar energy, wind energy, bio-energy, tidal energy, geothermal energy etc.

The non-renewable energy resources are defined as the energy sources which have been accumulated over ages & not quickly replaceable when they are exhausted. eg. fossil fuels, nuclear fuels and heat traps.

Advantages & disadvantages of renewable energy resources

Advantages

1. **Inexhaustible** : The renewable resources are non-exhaustible. The sun will continue to shine, wind will blow & water will flow & provide a virtually limitless supply of energy.

2. **Clean energy** : except biomass energy source all other renewable energy resources offer pollution free environment & also help in maintaining the ecological balance.

3. **Energy independence** : Reliance on renewable energy reduces dependence on imported fuels enhancing energy security & reducing vulnerability to supply disruptions and price fluctuations in global energy markets.

4. The diversity of renewable energy resources & their technologies offer more flexibility while designing the conversion systems compared to the conventional energy systems.

5. Local or regional self sufficiency in the energy requirement can be achieved either fully or partially by harnessing locally available renewable energy which otherwise would be left unutilized.

6. some renewable energy conversion systems often can be built on, or close to the site where energy is required which will minimize the transmission costs.

7. Advances in technology and economies of scale have made renewable energy increasingly cost-competitive with traditional fossil fuels.

Disadvantages

1. Intermittency & Variability :-
Renewable sources like solar & wind are intermittent & variable, depending on weather conditions. This variability poses challenges for grid stability and requires backup power sources or energy storage systems.

2. Geographic limitations :-
Not all regions have sufficient renewable resources. eg. areas with low solar irradiance or inconsistent wind patterns may not be suitable for large-scale solar or wind power generation.

3. Land use & Environmental impact :-
Large-scale deployment of renewable energy infrastructure such as solar farms & wind turbines, can require significant land area and may have environmental impacts, including habitat disruption and visual pollution.

4. Resource constraints :-
Some renewable energy technologies, such as certain types of biofuels & hydropower, rely on finite resources like agricultural land or water resources. overexploitation of these resources can lead to environmental degradation and conflicts over land and water use.

5. Initial costs & Infrastructure :—

While the long-term costs of renewable energy have decreased the initial investment cost for infrastructure such as solar panels & wind turbines can still be high, limiting adoption, especially in developing countries or regions with limited access to capital.

6. Transmission & Integration challenges

Renewable energy resources are often located far from population centers requiring extensive transmission infrastructure to transport electricity to consumers integrating large amounts of variable renewable energy into the grid also presents technical challenges

Solar Energy :—

Sun is the source of all life on the Earth. All forms of energy on the earth are derived from the sun.

Fuelled by the thermonuclear fusion, the sun radiates energy into space at a rate of nearly 4×10^{26} Watt. This energy is in the form of EM radiation with a wide range of wavelengths from short wavelength X-rays to long wavelength radio wave.

Sun is 145-153 million Km away or a little over 8 min at the speed of light. At the outer bounds of the earth's atmosphere, the intensity of solar radiation averages to about 1.35 kW/m² on average 30% is reflected or scattered back into space & 23% is remaining energy,

is absorbed by the oceans and converted into heat at ambient temperature. The total amount of energy captured each year by the earth its atmosphere and the hydrogen cycle is 3.8×10^{24} J.

The intensity of incoming solar radiation at any place on the earth's surface depends on multitude of factors such as time of the day and the year, latitude, the season, extent of cloud cover, atmospheric pollution & height above sea level.

Solar Energy conversion

- Heliochemical Process → The heliochemical process is a photosynthesis process which is the source of all fossil fuels and the food on which we live today. Photosynthesis is a form of biological conversion of solar energy into chemical energy called bioenergy

- Heliolectrical Process → In this process using photovoltaic effect, the solar energy is directly converted into electrical energy.

- Heliothermal Process → In the heliothermal process, the radiant solar energy falling on a surface placed on the earth in the form of visible light is converted directly into thermal energy.

Wind energy

Wind energy is the kinetic energy associated with the movement of large masses of air over the earth surface. The circulation of air in the atmosphere is caused by non-uniform heating of earth's surface by the sun. The air immediately above a warm area expands. It is forced upwards by a cool denser area & the angle of the sun in the sky are all the factors which influence this process.

Wind speeds increase with the height. They have been traditionally measured at a standard height 10m where they are found to be 20-25% greater than close to surface. At a height 60m, they may be 30-60% higher b'coz of reduction in drag effect of earth surface.

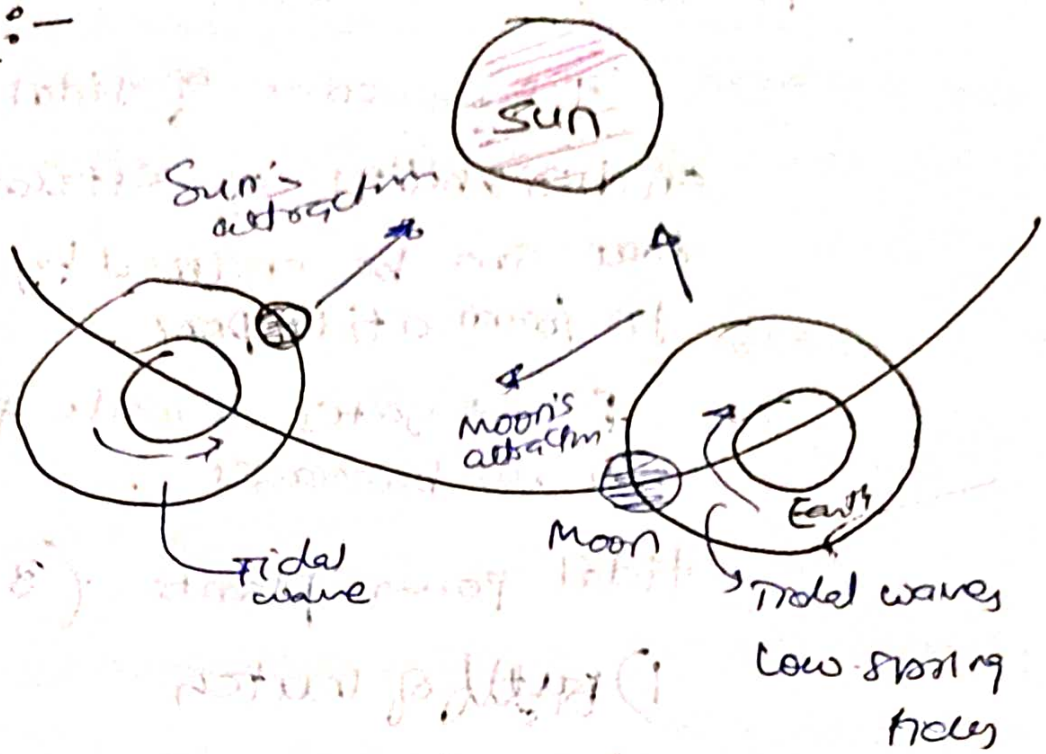
$$E = \frac{1}{2}\rho V^2 \quad J/m^3$$

$$P = EV = \frac{1}{2}\rho V^3 \quad W/m^2$$

Wind energy conversion :-

A windmill is the oldest device built to convert the wind energy into mechanical energy used for grinding, milling & pumping applications. It consists of a rotor fitted with a large sized blades

Tidal Energy:-



The gravitational forces exerted on the earth by the sun & the moon cause the displacement of ocean waters. As earth rotates surface of ocean water alternately rise & and falls at a particular location. Although rise & falls of tides are due to the gravitational pull by moon as it circles round the earth.

the moon's gravitational force induces a water bulge, called tide, on the near side surface of the earth. simultaneously a second bulge of the same magnitude occurs on the far side of the earth as result of centrifugal forces generated by the earth's rotation

The tidal range the height b/w high & low tides is greatly affected by the positions of the earth to the moon & the sun. The large tidal range is called Spring tide & the minimum tidal range is called neap tide.

Tidal energy conversion

The harnessing of tidal energy depends on availability of estuaries & bays that can be enclosed by barrage (dam) to form a tidal pool.

Flood gates & water turbines are installed in the barrages.

tidal power plants (3 Potential sites in India)

i) Gulf of Kutch

ii) Cambay on west coast of Gujrat

iii) Sunderbans on ~~east coast~~ of West Bengal.

Ocean Thermal Energy

Solar energy incident on earth surface is absorbed land as well as surface of ocean wat.

The solar energy absorbed by ocean increases temp. of only upper layers of water while deep water remains relatively cold.

The warm water will not mix with deep cold water due to density diff.

The solar heating of ocean water combined with earth's rotation produces some large convection current.

OTEC (Ocean thermal energy conversion)

warmed surface water & cold deep water provides (heat source & a sink) & very good condition needed to operate a heat engine.

eg:- Andaman & Nicobar Islands
Lakshadweep

Geothermal Energy

Hot water springs ; steam geysers.

80°C for each 1000m penetrated

Steam from geothermal well can be directly used to run conventional steam turbine

Nuclear Energy fission & fusion

Hydro Energy water / flood / dams etc.